# TRANSACTIONS

of the

# American Fisheries Society

"To promote the cause of fish culture; to gather and diffuse information bearing upon its practical success, and upon all matters relating to the fisheries; to unite and encourage all interests of fish culture and the fisheries; and to treat all questions of a scientific and economic character regarding fish."

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# PROCEEDINGS

of the

# American Fisheries Society

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## Forty-Ninth Annual Meeting

Louisville, Ky., October 8th, 9th and 10th, 1919

Headquarters, Seelbach Hotel

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### Opening Session, Wednesday Morning, October 8th, 1919.

The meeting was called to order by the President, Hon. M. L. Alexander, Conservation Commissioner of Louisiana.

Hon. Edward J. McDermott, formerly Lieutenant-Governor of Kentucky, was then introduced and welcomed the Society to Louisville and Kentucky in a pleasing address.

Hon. W. H. Killian, Conservation Commissioner of Maryland, was called upon to respond to the address of welcome.

A short business meeting followed.

Owing to the defection of the stenographer who took the report of the earlier sessions, the exact record of the proceedings with all of the discussion, has been lost, up to the afternoon session of October 9th. Fortunately, certain matters were preserved in the hands of the officers of the Society and among these were the reports of the Treasurer and Corresponding Secretary, the list of new members elected, etc.

## REPORT OF THE TREASURER.

GLOUCESTER, MASS., Sept. 27, 1919.

*To the American Fisheries Society:*

I herewith submit my annual report as Treasurer from the meeting in September, 1918, to the 27th of September, 1919.

### RECEIPTS.

| | | | |
|---|---|---|---|
| Balance in Treasury | | $142.59 | |
| Annual dues: | | | |
| For year 1912 | $ 2.00 | | |
| For year 1913 | ..... | | |
| For year 1914 | 8.00 | | |
| For year 1915 | 18.00 | | |
| For year 1916 | 36.00 | | |
| For year 1917 | 48.00 | | |
| For year 1918 | 602.00 | | |
| For year 1919 | 36.00 | | |
| For year 1920 | 6.00 | | |
| | | $756.00 | |
| Sales of Transactions | | 280.73 | |
| Collection on checks, etc | | .19 | |
| | | | $1,179.51 |

### DISBURSEMENTS.

| | | |
|---|---|---|
| Waldorf-Astoria, rent of typewriter; phone | $ 6.50 | |
| Elite Letter Co., multigraphing | 4.00 | |
| Bastian Bros., celluloid buttons | 25.04 | |
| J. C. Hall Co., book of receipts | 8.00 | |
| J. J. Farrell, clerical services | 25.00 | |
| J. B. Lyon Co., circulars, envelopes | 27.50 | |
| Gloucester National Bank, adjusting uncollectible check | 4.00 | |
| Waldorf-Astoria | .80 | |
| Gloucester National Bank, adjusting account | 2.00 | |
| Thorpe & Martin Co., letter file | 1.40 | |
| Postage (Treasurer) | 18.80 | |
| Postage and insurance on Transactions sold | .28 | |
| Postage (Corresponding Secretary) | 1.34 | |
| Bucher Engraving Co., work for Transactions | 1.00 | |
| Postage (Editor) | 6.00 | |
| Postage (Treasurer) | 13.50 | |
| Allen Bros., rubber stamp | .50 | |
| Wright & Potter Pr. Co., letter heads | 6.25 | |
| Rexford L. Holmes, reporting 1918 meeting | 190.92 | |
| M. Riddell, multigraphing | 3.57 | |
| Bucher Engraving Co., work for Transactions | 11.98 | |
| Postage and envelopes (Corresponding Secretary) | 4.04 | |
| L. B. Rimbach, clerical services | 100.00 | |
| Goodwin Bros. Printing Co., circulars, app'ns., etc | 39.25 | |
| Goodwin Bros. Printing Co., circulars | 12.50 | |
| Goodwin Bros. Printing Co., letter heads | 8.50 | |
| John P. Woods, stenographic expenses, stamps, envelopes, express, etc | 22.57 | |
| | | $ 545.24 |
| Balance, per Cash Book | | $ 634.27 |

PERMANENT FUND OF THE SOCIETY.

| | |
|---|---|
| Balance as reported at 1918 meeting | $2,995.96 |
| Interest, February 1st–Aug. 1st, 1918 | 59.90 |
| | $3,055.86 |
| Disbursement, C. G. Embody, prize paper | 100.00 |
| Balance | $2,955.86 |

(Signed) ARTHUR L. MILLETT,
*Treasurer.*

Referred to the Auditing Committee.

REPORT OF THE CORRESPONDING SECRETARY.

The Corresponding Secretary, having in his possession a large stock of TRANSACTIONS of the Society, undertook the disposal of several sets to university and public libraries.

TRANSACTIONS were sold to the following named institutions, for the amounts set opposite their names:

| | | |
|---|---|---|
| Harvard College Library | $10.50 | |
| Ohio State University Library | 12.25 | |
| Rutgers College Library | 32.00 | |
| Yale University Library | 33.50 | |
| Leland Stanford Junior University | 16.50 | |
| University of the State of New York | 9.50 | |
| Academy of Natural Sciences | 33.50 | |
| Museum of Natural History (New York) | .50 | |
| New York Public Library | 10.50 | |
| Canadian Biological Stations: | | |
| St. Andrews | 33.50 | |
| Nanaimo | 33.50 | |
| Public Library, City of Boston | 29.00 | |
| | | $254.75 |

The total amount resulting from these sales, $254.75, has already been deposited with the Treasurer, Mr. Arthur L. Millett.

Respectfully submitted,

C. H. TOWNSEND,
*Corresponding Secretary.*

Dated, New York, October 16, 1919.

Approved by action of the Society, with thanks to Dr. Townsend for his active and practical interest in the welfare of the Society.

NEW MEMBERS.

A complete list of those elected during the meeting is appended to the membership list as published in the September number of the TRANSACTIONS.

## REPORT OF THE COMMITTEE ON UNIVERSITY COURSES IN FISH CULTURE.

The American Fisheries Society as assembled in New York City, September, 1918, passed the following resolution:

WHEREAS, the conditions of the present have shown the need of developing the food resources of the country to meet the demands not only at the present moment, but also in the future, and

WHEREAS, the opportunities for securing specific training in the principles of fish culture are extremely limited, if not entirely lacking in the educational institutions of the country, and

WHEREAS, such training is important not only in the service of the state and nation, but also to the individual land owner, who can advantageously engage in fish production on a small scale in connection with his agricultural activities; therefore, be it

*Resolved*, that the American Fisheries Society recommend the establishment of courses in fish culture, which will open a new field of activity for many who find themselves adapted to such work and at the same time furnish a force of trained workers to meet the demand of state and nation.

That this may be achieved in most effective fashion, the President of the Society is hereby directed to appoint a committee of five to consider the plan of procedure which shall best attain the desired end.

This committee as appointed by President M. L. Alexander, consists of: Professor G. C. Embody, Chairman, Cornell University, Ithaca, N. Y.; Dr. R. C. Coker, U. S. Bureau of Fisheries, Washington, D. C.; John W. Titcomb, Conservation Commission, Albany, N. Y.; Professor Raymond C. Osburn, Ohio State University, Columbus, Ohio; Prof. Jacob Reighard, University of Michigan, Ann Arbor, Mich.

In the above resolution this Society recommends the establishment of courses in fish culture in the educational institutions of the country. The duties of this committee are then to suggest a plan of procedure which shall best attain the desired end.

After due consideration of the matters involved, the following report is offered:

## I. *Full Term Courses in Fish Culture.*

It is the consensus of opinion that a well equipped university, by a properly selected course of study, may give everything necessary for the student of fish culture except the practical work. Therefore, at least four different classes of students may be partly or wholly provided for, namely, those who would become (1) Practical Fish Culturists, (2) Teachers of Fish Culture, (3) General Investigators of Fish Cultural Problems and (4) Fish Pathologists.

All universities now offer courses in the fundamental subjects, such as general biology, zoology, botany, physics, chemistry, etc. In addition to these the committee suggests the following as being essential to the proper training of students for the four classes of work enumerated. The subjects considered most important are placed early in the lists.

### *A. For Practical Fish Culturists.*

Ichthyology.
Limnology (aquatic zoology and botany).
Principles of Fish Culture.
Practice in Fish Culture.
The Hydrology and Mechanics of Fish Cultural Problems.
Animal Physiology.
Principles of Nutrition.
Genetics and Principles of Breeding.

### *B. Teachers of Fish Culture.*

The subjects should be the same as for Practical Fish Culturist, but the amount of practical work required may be advantageously diminished.

### *C. For General Investigator.*

Ichthyology.
Limnology (aquatic zoology and botany).
Principles of Fish Culture.
Practice in Fish Culture.
Hydrology and Mechanics of Fish Cultural Problems.
Parasitology.
Animal Physiology.
Biochemistry.
Principles of Nutrition.
Embryology.
Bacteriology (General and Pathogenic).
Genetics.

*D. For Fish Pathologist.*

Ichthyology.
Limnology.
Principles of Fish Culture.
Bacteriology.
Parasitology.
Histology.
Pathology.
Fish Diseases.
Animal Physiology.
Biochemistry.
Principles of Nutrition.
Embryology.
Genetics.

In addition to the courses outlined under C and D, research in some special line should always be considered essential.

*II. Short Courses.*

Certain agricultural colleges now offer short courses for students unable to devote a full year to study. The entrance requirements are usually low, or entirely lacking, and the type of student is often below the average educationally. Nevertheless, these short courses are working towards better agriculture and, in the opinion of the committee, similar courses in fish culture would raise the standard of fish culturists and at the same time make the younger men more quickly available.

It is therefore recommended that short courses in the following subjects be given in those universities now offering short courses in agriculture.

*Subjects for a Twelve Weeks' Course in Fish Culture.*

Principles of Fish Culture.
Fish Life.
Forage Organisms.
Fish Feeding.
Fish Breeding.
Fish Diseases.

*III. Practical Work in Fish Culture.*

There are probably few universities so situated as to be able to maintain plants for fish production large enough to give the student the necessary practical work. It will therefore be necessary for state, national and private commercial hatcheries to co-operate with the universities to the extent of furnishing employment to students for a part of the year at least.

A parallel case is to be found in the agricultural college requiring a certain amount of practical work for graduation. Here students are often employed on private farms during the vacation period. It ought not to be difficult to make similar arrangements between universities and those operating hatcheries for the latter to employ worthy students of fish culture.

Wherever it is possible for a university to maintain a plant for fish production, this is to be strongly recommended because of the many advantages to be derived from the close contact of student with the actual work of the hatchery and because of the opportunities here offered for specialists to engage in the study of the many unsolved problems of fish culture.

### IV. *Financial Aid.*

The training of men to engage in practical fish culture and the investigation of fish cultural problems cannot be done without adequate financial support. Especially is this true of the latter, in which case special and expensive laboratory apparatus is essential to success and in which the results are obtained only after careful and prolonged research.

It is most urgent that more work be done upon the problems of fish diseases, fish forage, selective breeding of fishes, pollution and others which vitally affect successful fish culture. However, we must not expect that these can be satisfactorily solved without financial assistance.

We are forced to believe that one of the greatest reasons why progress in fish culture has not been as rapid as in many other branches of husbandry, is a lack of financial support. For these reasons we strongly recommend:

*First.* That state and national governments, and persons who may wish to advance the worthy cause of fish culture, render financial aid to those universities disposed to offer the courses outlined in this report.

*Second.* That so-called "industrial fellowships" in subjects relating to fish culture be established in institutions possessing facilities for research to the end that properly qualified investigators may be encouraged to work on the problems most vitally and immediately affecting the interests of fish culture.

Respectfully submitted,

G. C. Embody, *Chairman*,
R. C. Coker,
John W. Titcomb,
Raymond C. Osburn,
Jacob Reighard,
*Committee.*

(This report was approved by vote of the Society. Unfortunately the discussion of the matter has been lost through the fault of the stenographer.)

APPOINTMENT OF COMMITTEES.

President Alexander appointed the following committees to serve during the meeting:

*Committee on Nominations:* Messrs. Geo. H. Graham, E. W. Cobb, Dwight Lydell, John M. Crampton, S. W. Downing.

*Resolutions Committee:* Messrs W. H. Killian, A. L. Millett, L. H. Darwin, W. D. Barber, Linus Leavens, E. A. Tulian, W. D. Howser.

*Committee on Time and Place of Meeting:* Messrs. James Nevin, G. N. Mannfeld, John H. Wallace, Jr., Alva Clapp, Richard Porter.

*Committee on Awards:* Messrs. John W. Titcomb, A. L. Millett, Carlos Avery, Raymond C. Osburn, J. A. Williams.

*Program Committee:* Messrs. Raymond C. Osburn, John P. Woods.

*Auditing Committee:* Messrs. M. D. Hart, C. F. Culler, C. O. Hayford.

*Committee on Membership:* Messrs. E. A. Tulian, E. W. Cobb.

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**Wednesday Afternoon Session, October 8th, 1919.**

The entire afternoon was spent on an automobile drive as the guests of the Kentucky Game and Fish Commission. During the course of the trip, various sections of the city were visited, as well as the United States Fish Hatchery, where an hour or so was spent in the inspection of the Pumping Station, the Breeding and Rearing Ponds, etc.

The drive then led through Iroquois Park, where splendid views of the city and surroundings were obtained on a high hill; thence to Camp Taylor, and finishing with a drive of several miles along the Ohio River.

## Wednesday Evening Session, October 8th, 1919.

A very enjoyable banquet was tendered the members and lady guests of the Society by the Kentucky Game and Fish Commission in the rooms of the Pendennis Club.

Following a thoroughly good dinner, the toastmaster, Mr. John P. Woods, called upon various members, among them, President Alexander and Messrs Carlos Avery, John H. Wallace, Jr., Raymond C. Osburn, J. Q. Ward, E. E. Prince, J. A. Williams, Gro. H. Graham and W. H. Killian.

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## Thursday Morning Session, October 9th, 1919.

READING OF PAPERS.

### *Water Pollution.*

A paper prepared by the Massachusetts Fish and Game Commission and presented by Mr. David L. Belding, Biologist of the Commission.

Mr. Belding stated what has been accomplished in Massachusetts and outlined the work to be attempted in the near future. The plans contain a thorough educational program on pollution and its effects to acquaint the people of the state with this abuse of public waters.

### *Report on the Shad Situation.*

By Mr. G. C. Leach, U. S. Bureau of Fisheries. Extensive propagation was advocated as the only means of preventing the extinction of the shad as a commercial fish and of restoring it to its proper importance in our food supply.

After extended discussion, it was moved and carried that a special committee be appointed, consisting of representatives of coastal states and provinces and of the commercial interests, to whom this matter should be referred for consideration.

## Thursday Afternoon Session, October 9th, 1919.

COMMITTEE ON TIME AND PLACE OF MEETING.

The Committee presented a report favoring Ottawa, Canada, as the next meeting place, and the date as September 20, 21 and 22, 1920.

On motion, duly seconded, the report of the Committee was approved by vote of the Society.

READING OF PAPERS.

*A Plea for a Systematic Study of Fish Diseases.*

By W. M. Keil, Tuxedo Park, N. Y.

Mr. Keil requested that one day be devoted entirely to the discussion of fish diseases and parasites, at some meeting of the Society in the near future.

The request embodied in the paper was referred to the Executive Committee.

*The Chesapeake Bay.*

By Talbot Denmead,
Chief Deputy Warden of Maryland.

This paper appears in this number of the Transactions.

*The Prime Essential in Commercial Fish Conservation.*

By Wm. K. Mollan,
President of the Connecticut State Board of Fisheries and Game.

This paper, with the discussion which followed, appears in this number of the Transactions.

*Changing Food Conditions of the Trout Family.*

By James Nevin,
Division of Fisheries, Wisconsin Conservation Commission.
(See Transactions for December, 1919, Vol. XLIX, No. 1, pp. 29-32).

*The Blackspot Disease of the Bullhead or Hornpout.*

By Prof. Raymond C. Osburn,
Ohio State University, Columbus, Ohio.

Dr. Osburn also presented photographs illustrating the disease, together with bottled specimens of the blackspot tumors.

*Why Do Salmon Ascend From the Sea?*

By Prof. Edward E. Prince,
Dominion Commissioner of Fisheries, Ottawa, Canada.

This paper, with discussion, will appear later in the Transactions.

REPORT OF THE AUDITING COMMITTEE.

The auditing Committee has examined the statements, vouchers and books of Mr. Arthur L. Millett, Treasurer, and find them correct.

(Signed) M. D. Hart, *Chairman*,
C. O. Hayford,
C. F. Culler.

The report was approved.

The Society adjourned to meet at 8:00 o'clock, P. M.

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**Thursday Evening Session, October 9th, 1919.**

READING OF PAPERS.

*The Growth of Fishes.*

By Dr. A. G. Huntsman,
Toronto University, and head of the Atlantic Biological Station of Canada, at St. Andrews, N. B.

In the absence of Dr. Huntsman, this paper was read by Prof. Edward E. Prince. This paper has already been printed, with the discussion which followed, in the Transactions for December, 1919, p. 19-23.

*Fresh Water Mussels as a Fish Food.*

By Dwight Lydell,
Comstock Park, Mich., Superintendent of the Hatchery.

This paper was read by Mr. John W. Titcomb, and has already appeared in the Transactions for December, 1919, pp. 24-28, together with the discussion.

*The Preservation of the Alewife.*

By David L. Belding,
Biologist to the Massachusetts Fish and Game Commission.

Mr. Belding's paper, with the discussion, appears in this number of the Transactions.

The Society adjourned, to meet at 9:00 o'clock, Friday morning.

## Friday Morning Session, October 10th, 1919.

READING OF PAPERS.

*Beneficial Results of the Introduction of Plant Life in Trout Ponds at the New Jersey State Fish Hatchery.*

CHARLES O. HAYFORD,
Superintendent of the Hatchery, Hackettstown, N. J.

This paper was read by Prof. J. G. Needham, of Cornell University. See this number of the TRANSACTIONS.

*Louisiana, Greatest in the Production of Shrimp (Penaeus setiferus).*

By E. A. TULIAN,
Superintendent of Fisheries, Department of Conservation of Louisiana.

To appear, with the discussion, in a later number of the TRANSACTIONS.

BUSINESS.

PRESIDENT ALEXANDER: Gentlemen, before proceeding further, there is a question that the Nominating Committee would like to be advised upon before submitting their final report. That is the question of the position of the Recording Secretary, Corresponding Secretary and Editor.

(Dr. Prince was asked to preside temporarily.)

PRESIDENT ALEXANDER, continuing: I recommend to the Society that we have a permanent officer of some sort, who should be compensated for his services. He could devote the amount of time necessary to compiling the records of this Society and to keeping them in proper form, and to giving us a degree of publicity which would be a benefit to the Society. This obligation should fall either upon the Secretary or upon the Editor, who has represented this Society for a long period of years and who has devoted a large amount of his time to that work unselfishly and patriotically, we might say, in the interests of the Society. But the burden has become rather heavy upon him and it would be necessary to give more consideration should he take the position of Corresponding Secretary as well as that of Editor. It is a matter that I think should be discussed by the Society as a whole,

so that our Nominating Committee, in its further deliberations, may decide as to the officers best qualified to fill these positions.

(Mr. Alexander here resumed the chair).

Mr. Geo. H. Graham, of Massachusetts: If we are going to have this work carried on carefully and systematically we must have somebody do the work who will be satisfied with the compensation received. We have been coming to these meetings year after year, enjoying ourselves, paying our two dollars and going away. But we are asking one of our members to look after the work all through the year, and to give a large part of his time without any compensation, which is not really a fair proposition.

I will admit that up to this year we have not been in a position to do much financially, because we have been in debt. The first thing we must do is to arrange for more revenues and the question is, how are we going to do it? It seems to me that there are a great many sources of revenue we can logically call upon. In the first place, I believe every state should take out a state membership, similar to the one taken out by the State Commissioners in the International Association of Game and Fish Commissioners. There each state pays $25 as its state membership. You can readily see that $25, if all the states join, makes a thousand dollars to start with.

Now, the work that is being done by this association is beneficial to all the manufacturers and dealers in the United States and Canada who are making or handling lines, fish hooks, rods, reels, canoes, motorboats, and everything of that kind. Why should we not have a membership that would take care of these men. When they realize the actual benefit which they are receiving from the work of this organization, they should not hesitate in taking a membership. It seems to me it is a very simple matter to get a few hundred of these memberships at at least $5.00 per member.

There is another live source of revenue in the libraries. Every live library in the United States should be a member of this association and pay at least $2.00 a year, if not $5.00. My plan is this: Select a man for Secretary and tell him that for the first year we will give him $300 as his salary, with all legitimate expenses. At the end of the year we will see what he has done

and if we find we can pay him $500, let us pay him $500; if we find we can pay him $1,000, let us pay him $1,000. What difference does it make how much salary he gets so long as he gets in the money. If you will put it on that ground, you will get a man to put his time to it. There is no man in this room who will give his time to this thing for nothing. Why not make it attractive to somebody?

You all know that when these reports are sent out, every statement made by each member must be carefully edited. If you make an extemporaneous speech, it doesn't sound just as you would like to have it, perhaps, when it gets into print. The members here understand what you are trying to say, but in print it doesn't look well. We should each have a chance to correct what we say, before it goes into print. It takes a good deal of time to sort out the different sections and send them to the various speakers. Some of them negligently fail to return the corrected copy promptly as requested; some even wait two or three months before sending in their corrections.

Someone has to be patient and be on the job all the time. I would like to make a motion that some such plan as that outlined be put into effect and that we arrange to combine the two offices of the Corresponding Secretary and the Editor, and pay the incumbent $300.00 for next year.

Mr. W. H. Killian, of Maryland: I would like to second the motion and to say something in support of it. This is the Forty-Ninth Annual Meeting of the American Fisheries Society. Those of us who have been attending meetings for a sufficient length of time to see the scope of its work, know its possibilities are very great.

I do not like the name of Corresponding Secretary or Editor for a position of this kind. I think there is more force in a title like Executive Secretary or Business Manager. We understand the principles set forth by Mr. Graham for gathering sufficient revenue to continue this work as it should be continued, and not only to increase the revenue, but by reason of that activity to spread the influence of this Society by increasing the membership. The members would be more interested and would attend in larger numbers than has been the case in the past. I know from

experience that when you get the kindred trades interested in a society, as associate members, they always attend the meetings because they meet the people who are helpful to them in their business and they do a larger amount of advertising to the Society throughout the year. I wish heartily to endorse that idea and to second it.

Mr. A. L. Millett, of Massachusetts: It seems to me, before we go into the discussion, that we should hear from the man who has been our Editor for many years. I refer to Dr. Osburn.

Dr. R. C. Osburn: I did not mean to discuss this matter at all. I came here expecting to resign from office because I felt that, with the duties necessary to my university, I could not afford the time. I have given my time in the past because I felt it was my duty to the Society to do so. I fully intended to resign last year. I went to New York and found so many of our men engaged in war work of various kinds that I said to myself, "I will serve another year, anyway, and will make it my contribution to furthering the work of our fisheries."

Gentlemen, we must have more money if we are going to publish as we should. We are out of debt, to be sure, and have produced, I think, a very creditable journal. Our publishing bill for the past year will be approximately $700. If we are to publish all the valuable papers presented at this meeting the bill will be considerably more. I had to reject a number of papers last year for lack of funds. We will just about come out even this year after the bills are paid. We must have, then, more funds in order to carry on this work properly.

As to the name of the proposed office, if I may make a suggestion, the term "Permanent Secretary" rather appeals to me. It is used by other societies, such as the American Association for the Advancement of Science, the largest scientific body in our country and one of the most thriving.

I am not financially interested in the matter, for the amount of the salary suggested I consider merely an honorarium. You could not hire me to do it for anything like that amount. In the past years I have accepted the burden because of my interest in the work.

Secretary Woods: May I suggest that we do away with the name "Recording Secretary." In New York, at the solicitation of your Nominating Committee, I was induced to accept that position for one year. I am able to state, as my excuse, that I had an interest in the Society in that I had an opportunity to do in it very much good work. Now, there should be no delicacy about doing away with the office of Recording Secretary in order to have a Permanent Secretary, and if, by chance, you have in any manner considered me personally in the matter as an officer, I suggest that you overlook that entirely.

President Alexander: Gentlemen, I want to have publicly expressed my great appreciation of the very thorough and painstaking service of the Recording Secretary, Mr. Woods, during the past year. His services have been invaluable to the Society.

Mr. Graham's motion to combine the offices of Corresponding Secretary and Editor under some designated name and pay the officer $300.00 for the first year, being seconded, was unanimously carried.

President Alexander suggested leaving to the Nominating Committee the designation of the office.

Mr. Titcomb suggested that the Nominating Committee make provision for a Local Secretary, to attend to the secretarial work during the meeting. President Alexander spoke in approval of this suggestion.

Mr. Carlos Avery, of Minnesota: I would like to move also that the Committee be instructed to bring in a recommendation amending the by-laws as to membership dues. In order to pay this salary the money must be forthcoming, and there should be some different arrangement, as Mr. Graham suggests.

Personally, it appears to me that the regular dues might very well be raised. The value of a dollar is only about half what it used to be, and those who are paying $2.00 a year are really paying half what they used to pay. It seems to me there might be no serious objection to raising the dues to $4.00 or $5.00 a year, which would be a wonderful help in raising this additional money. The Permanent or General Secretary who may be

elected, and whose duty it will be to secure new members, can no doubt greatly increase the membership by the right sort of argument. If dues are slightly increased, it would seem that the necessary money would easily be forthcoming. I make that motion.

Mr. Titcomb: I second the motion, although I realize the larger number of men paying these dues are in reality receiving half the compensation they received before the war.

Mr. Graham: To me it would seem that the $2.00 membership should be left as it is, but why should we carry on this work for these thousands of other people who are not paying anything?

President Alexander: It is Mr. Avery's recommendation that we simply recommend to the Committee that it shall bring in any report they see fit. It is moved and seconded that a recommendation of this body go to the Committee to consider an advance in dues.

(The motion was carried unanimously).

READING OF PAPERS.

*A Word About Florida, Her Fish and Her Fisheries.*

By J. Azakiah Williams,
Conservation Commissioner of Florida.

Mr. Williams' paper will appear in a later number of the Transactions.

*Plants That Are of Importance in Ponds.*

By Dr. Emmeline Moore,
Madison, Wisconsin.

This paper with discussion, will appear in a later number of the Transactions.

Owing to lack of time, the following papers were read by title:

*Chemical Composition of Salmon During the Migration Fast.*

By Dr. Chas. W. Greene,
University of Missouri.

*Nitrogenous Changes, Etc., in Salmon.*

By Carl L. Greene.

*Concerning the Protection of Fish, Fish Food and Inland Waters.*

By Dr. Jas. A. Henshall,
Cincinnati, Ohio.

*The Retail Fish Market, Some Suggestions for Equipping and Conducting it.*

By Arthur Orr,
Bureau of Fisheries, Washington, D. C.

*Practical Fish Culture.*

By G. H. Thomson,
Estes Park, Colorado.

BUSINESS.

President Alexander: It is only half past twelve and we will continue in session until we complete the business of the Society. The Secretary has an announcement to make.

Secretary Woods: Mr. J. Q. Ward desires those who wish to go to Frankfort on Saturday morning to register here before we adjourn. I understand the object of the trip is to visit the State Hatchery.

REPORT OF COMMITTEE ON AWARDS.

Presented by Mr. John W. Titcomb, Chairman.

The contest for the prizes offered by the Society comes under three heads:

First: For the contribution showing the greatest advances in practical fish cultural work. Under this head there were two papers.

Second: For the contribution showing the best biological work applying to fish problems generally. No papers.

Third: For the contribution that best promises relief to and solving of the problems affecting commercial fisheries. Six papers.

In Group 1, the paper of Mr. Lydell entitled "Freshwater Mussels as Fish Food," is deemed by the Committee to deserve honorable mention, but it was presented too late to conform to the conditions of the award.

In Group 3, the paper which is awarded the prize is that by Mr. Louis Radcliff, "Fishery Products Laboratories Afford the Greatest Promise of Relief of Unsolved Problems Affecting Commercial Fisheries."

The paper by Mr. W. K. Mollan, the Commissioner from Connecticut, "The Prime Essential in Commercial Fish Conservation," is given honorable mention; and the paper by Mr. Arthur Orr, of the United States Bureau of Fisheries, is regarded as one treating on a very important subject, "The Retail Fish Market; Some Suggestions for Equipping and Conducting it." The committee expresses the hope that this paper can be used in some way in pamphlet form as propaganda to be sent broadcast throughout the country, in the hope that our conditions in the market may be improved.

The Committee has taken the liberty of making some recommendations, namely: (1) that the Society continue to hold these prize contests; (2) that notices of the proposed awards be sent out at least nine months in advance and also that they be published in the first number of the TRANSACTIONS; (3) that notice of intention to compete, with the subject, be submitted to the Secretary three months in advance of the annual meeting; (4) that the papers are to be submitted to the Secretary one month in advance of the annual meeting, and if possible that the papers be submitted in duplicate. It is further suggested (5) that the President name a Committee on Awards to judge the papers and that, in advance of the annual meeting, as soon as possible after the Secretary receives the competing papers, they be furnished to the chairman in order that the Committee may have ample time to go over them. The conditions provided two years ago are to stand, except for the changes here suggested.

After some discussion it was decided to eliminate the third point requiring three months notice of intention to compete, leaving as the only requirement, that the papers shall be in the hands of the Secretary one month in advance of the annual meeting.

With this change the report of the Committee on Awards was approved by vote of the Society.

REPORT OF THE COMMITTEE ON RESOLUTIONS.

Presented by the chairman, Mr. W. H. Killian, of Maryland:

(1). *Treaties With Cuba and Latin America.*

*Resolved*, That the President of the United States be, and he is hereby memorialized and requested to propose treaties with the Governments of Cuba and the Latin American Republics for the protection of fish which migrate between the United States and Cuba and such republics.

On motion, duly seconded, the resolution was adopted, Mr. J. A. Williams, of Florida voting in the negative.

(2). *Prevention of Water Pollution.*

WHEREAS, the Commission on Fish and Game of the State of Massachusetts has presented to this society through its biologist, Mr. David L. Belding, a paper on "Water Pollution," and

WHEREAS, said paper presents a definite plan for systematic and uniform action which may be adapted to the conditions in any state or province covered by the membership of this organization, therefore be it

*Resolved*, That the thanks of this Society are hereby extended to the Massachusetts Commission for their painstaking labor and their courtesy in supplying the Society with copies for distribution.

*Resolved*, also, that the states are hereby urged, through the Fish and Game Department of each, to take up this work at the earliest possible moment.

(Adopted unanimously).

(3). *University of Washington.*

WHEREAS, it comes to the notice of this Society that the State University of Washington has established a School of Fisheries, an undertaking which promises inestimable nation-wide benefit, and which is the fruition of long-felt hope, therefore be it

*Resolved*, That the American Fisheries Society extends its thanks and congratulations to the Faculty of the University of Washington and its wishes for the complete success of the enterprise.

(Adopted unanimously).

(4). *Cornell University.*

WHEREAS, Cornell University has established courses in fisheries work and game propagation, an undertaking which promises to be of very great value to the fish and game work of the whole nation, therefore, be it

*Resolved*, That the American Fisheries Society extends its thanks and congratulations to the Faculty of Cornell University and the hope that new courses may prove entirely successful.

(Adopted unanimously).

(5). *On the Death of Dr. Joseph Kalbfus.*

WHEREAS, Dr. Joseph Kalbfus, Secretary of the Board of Game and Fish Commissioners of Pennsylvania, and an honored member of this Society, the pioneer in this country in the establishment of state and game refuges, and a leader in securing the passage of model game and fish laws, and

Whereas, Dr. Kalbfus has departed this life since the last meeting of this Society, be it

*Resolved*, That in his death this Society has lost a wise leader and an able counselor, and its members a true and faithful friend; and

*Resolved*, That a copy of this resolution be sent to the members of the family of the deceased, together with our sincere condolences, likewise to the Pennsylvania Commissioners and to the sportsmen's papers throughout the country.

A standing vote was taken in honor of Dr. Kalbfus' memory and the resolution adopted unanimously.

(6). *The President of the United States.*

*Resolved*, That the American Fisheries Society deeply deplores the illness of our President, the Honorable Woodrow Wilson, and earnestly hopes that he may be speedily restored to vigorous health and active duty, and be it further

*Resolved*, That a copy of this resolution be sent to the Private Secretary of the President, Hon. Joseph P. Tumulty.

The resolution was adopted unanimously by a standing vote.

(7). *To Louisville, Kentucky, and the Kentucky Fish and Game Commission.*

*Resolved*, That the thanks of the American Fisheries Society be extended to the citizens of Kentucky and especially of Louisville, and in particular to the members of the Kentucky Fish and Game Commission, for the splendid hospitality so graciously accorded during this convention.

(Adopted unanimously).

(8). *To the Louisville Press.*

*Resolved*, That the thanks and appreciation of the American Fisheries Society be voted to the Press of the City of Louisville for the publicity given to the proceedings of this, the Forty-ninth Annual Convention.

(Adopted unanimously).

(9). *Extending Thanks To President Alexander.*

*Resolved*, That the thanks and appreciation of the Society be extended to Hon. M. L. Alexander, whose able administration during the year and dignified leadership during the convention have been of great value to the Society.

Secretary Woods assumed the chair and asked for a rising vote, which was given unanimously.

(10). *To Recording Secretary Woods.*

*Resolved*, That the thanks and appreciation of the Society be extended to Mr. John P. Woods, whose able, arduous labor and enthusiasm in the work of the Society have been an important factor in producing a most successful meeting.

The resolution was adopted unanimously by a rising vote.

(11). *Resolution To Extend the Three-Mile Limit.*

This resolution was drawn up by Prof. E. E. Prince, Dominion Commissioner of Fisheries for Canada. By the request of the Society, at its 1918 meeting, it was published, for fuller consideration, at the end of Dr. Prince's paper on "Territorial Waters and a Suggested Extension of the Three-mile Limit." See page 190, Transactions, American Fisheries Society, Vol. 48, No. 3, June, 1919.

Prof. Prince begged permission to withdraw or postpone action on the resolution, on the ground that certain representative men, much interested in the matter, were not present to discuss it.

Prof. Prince's request was granted and no further action taken on the resolution.

CHANGES IN THE CONSTITUTION.

The Committee on Constitution, Mr. Geo. H. Graham, Chairman, proposed the following changes:

(1) Combining the offices of Corresponding Secretary and Editor under the new office of "Executive Secretary," Article IV, paragraph 1, should be changed to read:

"The officers of this Society shall be a president and a vice-president, who shall be ineligible for election to the same office until a year after the expiration of their term; an executive secretary, a recording secretary, a treasurer, and an executive committee of seven, which, with the officers before named, shall form a council and transact such business as may be necessary when the Society is not in session—four to constitute a quorum."

The proposed change was unanimously approved.

(2) In order to provide the means for better financial support, Article II, paragraph 2, should be changed to read: "Any sporting or fishing club, society, firm or corporation, upon two-thirds vote and the payment of an annual fee of Five Dollars, may become

a member of this Society and entitled to all its publications. Libraries shall be admitted to membership at Two Dollars a year."

Libraries were at first included in this proposed change, but after some discussion, it was decided to admit them on the old basis at Two Dollars a year. With this exception, the resolution was adopted unanimously to read as above indicated.

(3) A change providing for State Membership. "Any state board or commission may, upon the payment of an annual fee of Ten Dollars, become a member of this Society and be entitled to all of its publications," this to constitute paragraph 3 of Article II.

After some discussion in which some of the members advocated a fee of Twenty-five Dollars, the resolution was carried unanimously in the form above stated.

Mr. Graham: There seem to be no other changes necessary. The Constitution was changed last year, permitting us to take in the Shell Fish Commissioners and we have made arrangements with Mr. Killian, of Maryland, to take the matter up with that Society. In all probability, when the next meeting of their Society is held at Atlanta, next May, they will vote unanimously to come into this organization and take State Memberships. Fifteen states belong to that organization and it will give us considerable revenue.

REPORT OF THE COMMITTEE ON NOMINATIONS.

Presented by Mr. Geo. H. Graham, of Massachusetts:

The Committee begs to present for your consideration the following names for Officers of the American Fisheries Society for the year 1919-1920:

*President*—Carlos Avery, St. Paul, Minnesota.
*Vice-President*—Nathan R. Buller, Harrisburg, Pennsylvania.
*Executive Secretary*—Raymond C. Osburn, Columbus, Ohio.
*Recording Secretary*—John P. Woods, St. Louis, Missouri.
*Treasurer*—Arthur L. Millett, Gloucester, Massachusetts.
*Executive Committee:*

G. C. Leach, Chairman, Washington, D. C.
George H. Graham, Springfield, Massachusetts.
W. A. Found, Ottawa, Canada.
William E. Barber, Lacrosse, Wisconsin.
W. H. Killilan, Baltimore, Maryland.
Dwight Lydell, Comstock Park, Michigan.
L. H. Darwin, Seattle, Washington.

*Vice-Presidents of Divisions:*

Fish Culture—James Nevin, Madison, Wisconsin.
Aquatic Biology and Physics—Henry B. Ward, Urbana, Illinois.
Commercial Fishing—J. Asakiah Williams, Tallahassee, Florida.
Angling—John M. Crampton, New Haven, Connecticut.
Protection and Legislation—J. G. Needham, Ithaca, New York.

*Committee on Foreign Relations:*

George Shiras, Chairman, Washington, D. C.
H. M. Smith, Washington, D. C.
Wm. C. Adams, Boston, Massachusetts.
James White, Ottawa, Canada.
Edward E. Prince, Ottawa, Canada.

*Committee on Relations with National, State and Provincial Governments:*

Henry O'Malley, Chairman, Seattle, Washington.
William L. Finley, Portland, Oregon.
Jacob E. Reighard, Ann Arbor, Michigan.
E. T. D. Chambers, Quebec, Canada.
George A. Seagle, Wytheville, Virginia.

Moved and seconded that the report be adopted as a whole and that the Recording Secretary be requested to cast a single vote for the Society. The motion was unanimously carried and the above named gentlemen were declared to be elected to serve as the officers of the Society for the year 1919-1920.

Retiring President Alexander: I now have the pleasure of introducing to you our new President, Mr. Carlos Avery, of St. Paul, Minnesota. I do not know any member of the Society who is more worthy of the honor and I feel quite confident that Mr. Avery's splendid executive ability and excellent qualities in every way, will enable him to give you a most successful administration of the office.

President Avery: Fellow members of the American Fisheries Society:—I hope you will realize that I am not unmindful of the distinguished honor that you have conferred upon me. I fully realize also the responsibilities that go with the position.

The American Fisheries Society is distinctly a scientific society, because of the investigations carried on by the scientific men who belong to it. From these investigations come the really solid

results. You are aware, of course, that I am not a scientific man. My experience has been wholly in an administrative capacity and if I have any capability at all it is in that direction, and, in the coming year, I must lean upon those who are more experienced and more competent in the real work of the Society.

The year before us is the semi-centennial year of the Society and I believe that if we have the full co-operation of all the membership we can make the next annual meeting a worthy celebration of this notable event. I bespeak the co-operation of all the members to that result, and invite your criticism and assistance throughout the coming year. I beg to thank you.

Mr. Alexander: I now make a motion that the Forty-Ninth Annual Meeting of the American Fisheries Society stand adjourned.

The motion was seconded and carried and President Avery declared the meeting formally adjourned.

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On the following day, Saturday, October 11th, a number of the members made an excursion to Frankfort, Ky., at the invitation of the Kentucky State Game and Fish Commission, to inspect the state fish hatcheries at that place. As this meeting was informal and not a part of the regular procedure of the Annual Meeting, no report of it has come into the hands of the editor. However, judging by our experiences of the hospitality of the Kentucky Commission, it is safe to say that the trip was a thoroughly enjoyable one.

## THE PRIME ESSENTIAL IN COMMERCIAL FISH CONSERVATION.

By William K. Mollan,
President, Connecticut Fish and Game Commission.

It is perhaps inevitable, it certainly is desirable, that devotees of the cause of fish conservation should become specialists; that each, having had his attention directed to some one outstanding subject among the many into which the general problem may be divided, should follow that particular branch of piscatorial research to the end, giving to its minutest ramifications the full of his thoughts. It is only by such absorbed devotion of the individual to one or another department of any science that that science attains to complete development; and the preservation and enhancement of fish life is a scientific field comparable with the best.

What the American Fisheries Society, the country and the world owe to those gentlemen who have devoted the thought and labor of their lives to the development of cold facts concerning the pollution of our waters, it is impossible to over-estimate; what is owed to the painstaking research of the students of fish habits we can never calculate, and the limitless patience and perseverance of the experimenters in artificial propagation have placed the world under heavy obligation to them.

It is only through the assemblage of the fruits of such specialized endeavor into a grand total of knowledge of the general subject that this Society finds itself in possession of a balanced mass of demonstrable facts and figures. It is only because one man has given his life to one department of research and another has followed a different line of investigation and still another a third, that the sum of available information is so much greater and more varied than any single individual has been able to find out for himself.

To the specialist, then, to the man who rides his particular hobby hard, to the individual who allows himself no leeway, but confines his labors to the development of a single-track idea, the

cause of fish life owes substantially everything. Without him, the very word "conservation" as applied to the fauna of our seas and waterways would be wholly meaningless. Instead of hope for the future we should have only regrets for a hopelessly dead past. The entire structure of present conservation effort and the blue print of the more ambitious efforts of the future are planned from data which these scientists, both professional and amateur, have supplied and are continuing to supply.

To the person already attracted to the general subject of fish life, nothing could be of more absorbing interest than the minutiae of the various steps by which our provable volume of fish lore has been gathered together.

Unfortunately, decision as to what steps shall be taken for the conservation of fish life, or how soon or on how considerable a scale, does not rest with those who have hitherto taken either a specialized or a general interest in the subject. Nor does there seem to be even a remote likelihood that there can be set up, in the minds of those on whom those decisions do rest, any ponderable degree of interest in the finer details of research and experiment. Legislators, congressmen, those persons in authority from whom we must seek action founded on economic necessity, will not use the reading glass to study the microscopic details which make up the sum of our knowledge of fish life and fisheries necessities. We shall do well if we can soon get enough of them to glance at the poster drawings which we must presistently shake before their eyes.

Such propaganda as the American Fisheries Society and kindred associations shall set afoot in the interest of the commercial fisheries must be presented in bold, splashy drawing. It must have few lines, and striking ones. It must be planned and calculated to catch the eye and the fancy of him who runs. It must be burdened with as little as possible of that circumstantiality which appeals to the initiate, but which is merely "dry scientific stuff" to the average citizen and to the average legislator.

Can we do better than to concentrate, in any effort to rehabilitate and preserve our commercial fisheries, on such obvious and elementary matters as the following:

1. Preservation of the availability, to the fish, of their natural spawning beds.

2. Protection of the fish on the beds, and during their migrations thereto.

3. Protection of the young fish from wholesale slaughter during infancy.

4. Protection of the food supply of commercially valuable food fishes.

In this very brief discussion of the problems of the country's commercial fisheries, the writer, from the limitations of his experience, necessarily approaches the subject from the viewpoint of the Atlantic seaboard states, and must confine himself to suggestions relating to those migratory fishes which would become the wards of the nation in the event of the passage of a migratory fish law comparable to the existing migratory bird law. Inland and deep sea fisheries, save in the matter of general principles, are not here considered. But even within such restricted lines there is enormous need of enlightenment among the public and the public's official servants on the broad principles of conservation; upon the far-reaching effects of present day wastage and upon the ways and means of preventing it.

It is probable that out of every hundred persons who have read at one time and another detailed, convincing statements of the injury done to fishes by the pollution of rivers, ninety-nine have jumped to the conclusion that the problem is a local one, both as to effect and remedy. And that those who have heard of the destructive effects of overfishing almost never think of those effects as bearing upon localities distant from the immediate scene of the wastage. Yet the poisoning of the waters of the Connecticut and Housatonic rivers in the writer's state have no more direct bearing on the shad supply of Connecticut than upon that of New Jersey or Maryland. It affects the entire matter of shad propagation on the Atlantic coast. It is an affair of interstate concern.

Perhaps the best possible illustration of the idea of far flung consequences of local conditions is furnished by the unspeakable practices with relation to striped bass that exist in the Roanoke river, North Carolina, where the bass are ruthlessly slaughtered by the thousands while on their way to the spawning beds. It is claimed, and certainly with considerable if not absolute truth, that the Roanoke river is the natural spawning place of by far

the greater part of the Atlantic coast striped bass. And yet the fish are being taken there in utter disregard of the rights of the fisheries of every other state on the seaboard, the entire striped bass supply of these other coastal states recklessly diminished by the destruction of the spawn bearing parent fish, and a highly valuable commercial fishery rendered unimportant where it has not been wiped out.

It is conceivable that stream pollution may be a matter of direct concern only to a certain state, when it relates to waterways which have not been chosen by migratory fishes as the scenes of their procreative activities. But when a stream has been selected by a fish species to be the nursery of its young, as the Connecticut has been chosen by the shad or the Roanoke by the striped bass, then the conditions in that stream and the laws governing them are no longer properly to be left to the control of the individual state. The stream, the spawning beds, the regulation of fishing with respect to the spawning fish, straightway become the business of the nation. To assume that the fishes of the waters of many states become the legitimate prey of the people of a single state to which they pay a temporary visit for the purpose of reproduction, and are rightfully to be exploited to the point of extermination, without adequate regulation, by the people of that state, is to deny that any American state owes the slightest obligation or duty to any other; which is, of course, an untenable position in law and ethics.

By sticking to the simpler, less complex and more striking demonstrations of the problem it should be possible to bring to members of congress the conviction that unless all the food resources and industries embodied in the groups of salt water fishes that spawn in inlets and rivers are to be wiped out, the federal government must assume control.

The pollution of the waters of spawning areas must be forbidden by national enactment.

Fishing on spawning areas must be forbidden and the fish protected against capture while on their way to the areas, by national enactment.

The netting of immature fishes must be prevented by regulating the size of net meshes, by national enactment.

In other words, there can be no adequate betterment of conditions with relation to our migratory coastal fishes until the real owner of those fishes, our Uncle Samuel, bestirs himself to safeguard his own interests, instead of trusting the task to individual states which will never assume responsibility for what is not their own and in the nature of things cannot be theirs.

This leaves one other division of this subject to be considered. It is one that has been far too much neglected. I refer to the protection of the food of food fishes.

Some time ago there was prepared by a statesman of one of our Atlantic states a bill providing legal protection for many varieties of salt water fishes. It was carefully drawn, this bill, and it would have restricted the taking of this fish and that, always with a view to conserving the species while permitting the capture of merchantable specimens in considerable quantities. It protected the bluefish, the bonito and all the rest of the predatory varieties that live upon finny bait fish, but it said not a word about the menhaden. Under the law the last menhaden in the world might have been legally destroyed, yet the menhaden is the fundamental food of half the varieties this man was so solicitous about! And incidentally it has been for years the most ruthlessly slaughtered form of life in the ocean.

Thirty or forty years ago the waters of the North Atlantic for hundreds of miles along the American coast fairly teemed with countless millions of menhaden. The peculiar milling wake of a hundred vast schools of these creatures could be noted in any summer day's sail upon these waters. And as the menhaden swarmed, so proportionately thrived the blue fish, the bonito and other large fishes of the mackerel family, which followed and fed upon the illimitable supply of menhaden bait. The whole north Atlantic seaboard in those days was alive with edible fishes of the finest varieties, all regular boarders at the menhaden table.

Even in those days there was a snug little industry in the production of menhaden oil and fertilizer. But the catches made little apparent inroad on the supply, which seemed inexhaustible. Then came the formation of great companies that built big vessels and employed new and gigantic devices in the capture of the "bony fish," as they call them in New England. By and by the menhaden began to grow scarcer. They were taken at all seasons

and in all waters, finally even chased into the inlets where the last of the great schools sought refuge. The menhaden were overfished out of existence, or nearly so. When they disappeared, then too disappeared, in very large measure, the fine, valuable food fishes which depended for their existence upon the existence of their natural prey.

There has never been the slightest prospect of successfully regulating the taking of menhaden by the individual states. The menhaden fisheries were highly profitable and controlled by influential capitalists, and it was useless for one state to adopt restrictive laws which were not in force in the neighboring states. But if we had had, during the last twenty-five years, a federal migratory fish law which included the protection of the most important element in the whole category of coastal fishes, the food of food fishes themselves, it is a hardy soul who will contradict the guess that the take of food fishes of the blue-fish and bonito class, in the year 1919, would have been ten times what it will be this year.

Give us a sane and just federal migratory fish law, providing at once all proper liberty for present fishing and a rational regard for the fishing of the future, and above all protecting from extinction or undue depletion the sustenance of the fishes, and there will be restored to the people of the country a highly important food factor now become almost negligible, and to the pockets of the fisherman of our costal states many millions of dollars annually.

## THE CHESAPEAKE BAY.

By Talbot Denmead,
Chief Deputy of the Conservation Commission of Maryland.

The purpose in selecting this subject is to give me something to talk about which I know intimately, for it is with considerable hesitancy that I address this body. As you are all so much better acquainted with fish and fish matters than myself, who have always been a hunter first and a fisherman next, I feel that if there is any message I can bring to you it will be about conditions affecting my own Chesapeake, where I am at home.

The Chesapeake Bay lies entirely within the states of Virginia and Maryland, the former controlling the lower waters, or south end of the bay, where the fish enter from the Atlantic Ocean, and the latter controlling the northern waters, where the fish go to spawn. Since the time of George Washington there has been an unending dispute between these two states over the proper regulations pertaining to fish, oysters and crabs, and probably there always will be, unless the Federal Government assumes control over migratory fish that pass through one or more states in reaching their breeding grounds.

The Chesapeake Bay is unequaled in the country by any similar body of water. Its shore front, if stretched out in a straight line would reach from Maine to Florida; its waters teem with many varieties of fish and crabs; its bottom is covered with the finest oysters, and wild-fowl rest upon its not always placid bosom. Weakfish, striped bass, white perch, yellow perch, pickerel, large mouth bass, spot, king fish, blue fish, butter fish, catfish and wall-eyed pike are some of its fish.

At the head of the bay lies the Susquehanna Flats, a great spawning ground for many fish, as well as a noted feeding ground for wild fowl, where the celebrated canvas-back congregates in quantities, to feed and grow fat on the enormous beds of wild celery. Upon these flats flows the mighty Susquehanna River, after traversing the state of Pennsylvania, in whose clear and rapid waters the angler finds heaven in fighting the great striped bass and the smaller black bass.

### *Fish Refuges.*

Places where fish can spawn undisturbed by the netters is not a new proposition, but it has been tried with such success in several instances in Maryland that I am compelled to give you in detail the history of one of our successes along this line. This is one of the subjects in which I hope to interest you, namely: the experiment of prohibiting all netting in the Severn River, a tide-water tributary of the bay. Many years ago the fish had practically been cleaned out of this beautiful river by all kinds of nets, and it was not very hard to get the legislature to pass a law barring the netter. Two years of re-stocking, however, and the abolishment of the net, brought the fish back into this river in such quantities that the commercial fishermen made a concerted effort to repeal the law, and get into the river with their nets. Being defeated in this, they tried violating the law. The increase of fish had been so remarkable, however, that public opinion was against a repeal and the violators, and at the following session of the legislature the law was considerably strengthened. Violators were apprehended, convicted and fined, and they then decided it was wise to leave the river alone. The fish have continued to increase, notably the striped bass and white perch.

Now the beauty of this experiment was that it not only increased the supply of fish within the river, but actually served as a feeder for the waters of the bay surrounding the mouth of the river. In time this extended many miles away, thereby materially benefitting the commercial fisherman by providing a safe nursery for food fish until they were of marketable size and there were larger quantities outside in the bay where he could fish.

This experiment, or plan, for it is beyond the experimental stage, has also been tried in two other Maryland estuaries, namely, Dundee Creek and Sue's Creek, with very satisfactory results. It is well worth while and we hope to see the time very shortly when we have such refuges in every county in Maryland.

### *Federal Control of Migratory Fish.*

The other point I wish to emphasize is the necessity of some control, other than state control, over fish which winter in the sea and pass through one or more states to reach their spawning

grounds, such as is the case in the Chesapeake and other waters of the country. In our case it has been proven beyond question that state control proves a detriment to the interests of both states. This has been especially marked in regard to crabs which wintered in Virginia and were dug out of the mud during the winter months, and it was of no use for Maryland to try to protect them during the time they were in the waters of the latter state. The shad is another illustration. Entering the bay in Virginia on its way to the head of the bay to spawn, it is beset by nets through the entire length of the bay. Neither state is willing to give any protection which might in the least benefit the other state, and consequently the shad is a fair prey from the minute he sticks his nose into the Chesapeake. It is no wonder that less than one per cent of the shad reach their spawning grounds, though at least ten per cent, with the assistance of fish hatcheries, must reach the spawning beds to keep up the stock. This resulted in the closing of the United States Shad Hatchery at the head of the Chesapeake, as it was unable to obtain a sufficient number of eggs to pay for operating. The Conservation Commission of Maryland, however, has operated several floating hatcheries with considerable success, and is to be commended for its uphill fight for saving this fish, but, without Federal control, it is my opinion that little can be accomplished.

In conclusion let me say that co-operation and common sense are just as necessary in fish protection as in any other matter. No two states pulling different ways will get anywhere. I shall close without further remarks excepting to recommend to you *Fish Refuges and Federal Control.*

# RAISING FRESHWATER MUSSELS IN ENCLOSURES.

By Roy S. Corwin,
Scientific Assistant, U. S. Bureau of Fisheries.

Results of artificial infections of *Lampsilis luteola* on the gills of several species of game fishes, confined in enclosures in Lake Pepin, are throwing considerable light upon the problem of commercial propagation of fresh-water mussels for button purposes. Experiments begun in May, 1918, and continued up to the present, have been particularly instructive.

In order to make a quantitative test of methods of artificial propagation, enclosures or pens were constructed with board bottoms and sides of one inch mesh wire netting. The bottoms of the pens were covered to the depth of about one inch with sand taken from the shore above the water line. The pens were then submerged in water about five feet deep. Three localities in Lake Pepin were used: Lake City and Frontenac, Minnesota, and Stockholm, Wisconsin. A brief summary of the operations and findings in connection with several of the enclosures follows.

## *Lake City Enclosure*

Five lots of fishes, consisting of wall-eyed pike, sauger, small-mouthed black bass, white bass, yellow perch, sunfish and crappie, infected with the glochidia of *Lampsilis luteola,* on dates extending from May 16th, 1918, to July 3rd, 1918, were confined in the Lake City enclosure. This enclosure was 12 feet square and had sides from 6 to 12 feet in height. After deducting the number of fishes which died and those which either escaped from the pen or were caught out by fishing parties, it was found that 79 fishes had remained alive in the enclosure long enough to drop the young mussels.

From this enclosure on September 23rd, 1918, after a maximum of 130 days from the date of the first infection, were removed 11,199 live juvenile *L. luteola,* ranging in size from 16.0 millimeters to 3.0 millimeters. On previous dates 395 live juvenile luteola had been removed, making a total of 11,594 from the pen. To this might also be added 1000 pairs of valves of dead juvenile luteolas, making a grand total of 12,594.

On September 30th, 1918, approximately 11,000 of the live juveniles were returned to this pen, which was resubmerged in the lake to a depth which would enable the young mussels to escape freezing. Certain ones were measured carefully and numbered, and their dimensions recorded. These mussels were not disturbed until September of this year, when the pen bottom was raised and its contents examined.

The average growth of the mussels during the second year was found to be 16.72 millimeters. Only 80 live mussels were recovered, the largest being 37.0 and the smallest 6.7 millimeters long. An attendant circumstance was that hundreds of the second season mussels had been eaten by a turtle or bottom-feeding fish. A quart jar of shell fragments, hinges and umbones, showing first season shell plus part of the second season's growth, was recovered. These fine, strong shells had been crushed by the jaws of a mussel devouring animal. A count of hinges and pairs of umbones showed that 2,085 mussels had been destroyed in this manner. Thus the total yield of second year shells should have been approximately 2,165, which would still be less than one-fifth of the number of first season juveniles replanted in September, 1918.

### *Frontenac Enclosure*

During July, 1918, infected fishes were confined in the enclosure at Frontenac, which was 10 feet square and had sides from 6 to 9 feet high; 46 of the infected fishes dropped young mussels in the pen. Due to the lateness of the season, the bottom of the pen was but partly examined on November 11th, 1918, and no exact estimate of the number of juveniles was obtained, although several juvenile luteola were recovered which were from 4.0 to 2.5 millimeters long. These were returned to the pen, which was resubmerged.

On September 12th, 1919, 480 second season luteolas were recovered, the largest 30.8 and the smallest 7.4 millimeters in length. The average second season's growth was 19.35 millimeters.

### *Stockholm Enclosure*

Infected wall-eyed pike placed in the enclosure at Stockholm on August 6th and 14th, 1918, were still carrying practically the original number of glochidia on their gills when released on

November 10th, 1918. Although it was evident that but few, if any, young mussels had been dropped in this pen before the removal of the fishes, still the pen was resubmerged and left until September of this year, when it was raised and examined.

Seventy-two second season mussels were found. These showed clearly the first season shell, which measured from 1.4 to 2.3 millimeters, beyond which extended the second year's growth. The largest juvenile luteola from the Stockholm enclosure was 21.6 and the smallest 7.3 millimeters long. The average second season's growth was 15.26 millimeters.

### *1919 Enclosures*

The experimental work during the present season was conducted so as to show the relation of the length of the parasitic period to season and temperature of the water. The enclosures were constructed in two parts; a board bottom and a wire netting cage resting upon it which could be raised when desired. In all, 14 such enclosures were employed. Infections were made at about 15-day intervals from May 20th to September 4th. Several infections were made simultaneously in each of the three localities previously mentioned.

Generally speaking, it was found that glochidia placed on fish up to the middle of July, that is, in spring and early summer infections, required a shorter period for metamorphosis than those used in infections after July, late summer and fall infections. For instance, spawn placed on fish May 20th, dropped from the host in from 26 to 29 days, when the water temperature was rising from 60 to 78 degrees F. Spawn placed on fish June 5th dropped off in from 18 to 20 days—water temperature 68 to 78 degrees F.

Fishes infected July 1st, carried the young mussels from 14 to 68 days—water temperature falling 77 to 74 degrees F.

A significant observation was made on the behavior of old glochidia, that is, those which had been carried by the parent over the winter and spring; and new glochidia, that is, mature ones of the present season. On July 17th, two lots of fishes of the same species were infected and kept in separate but adjacent pens. The first lot was infected with old glochidia; the second lot was infected with glochidia of the present season. The first lot had completely dropped the young mussels within 14 days. Some

of the second lot of fishes were observed to be free from glochidia within 27 and 32 days, respectively, after infection. Others continued to carry as late as October 1st (92 days) and were kept in the enclosure for further examination.

From this it is believed that the least time for metamorphosis is required by glochidia taken from the parent shortly before the time when the parent would normally discharge the spawn preparatory to refilling the marsupial pouches, that is, during the month of July. The instances in which certain fishes infected July 1st dropped some mussels within 2 weeks and carried others 8 or 9 weeks, are explained by the fact that both old and new glochidia from several mussels had been used in the infection.

Late summer infections, those August 5th, August 19th and September 4th, require long parasitic periods, since fishes, when examined October 1st were found to be still carrying almost the original infection.

Glochidia placed on fish May 20th, 1919, grew to be mussels 5.5 millimeters long on July 26th (67 days); 11.0 millimeters long on August 27th (99 days), and 17.0 millimeters long on October 1, 1919 (134 days).

It is still too early to state the number of mussels raised per fish, but it is expected that this can be done before the close of the season.

# BENEFICIAL RESULTS OF THE INTRODUCTION OF PLANT LIFE IN TROUT PONDS AT THE NEW JERSEY STATE FISH HATCHERY.

By Chas. O. Hayford,
Superintendent, Hackettstown, N. J.

The rearing of brook trout at New Jersey State Fish Hatchery, located at Hackettstown, N. J., during the first year of operation (1913) was very successful, but the work of the second, third and fourth years proved quite discouraging. During these years, after the fish had reached a length of from 1½ to 3 inches, we had trouble with them until they attained to 5 or 6 inches. Brown trout were affected in the same manner as the brook trout, but not to such an extent.

During the second year, 1914, we experimented with various foods. For the fish that had reached 1½ inches, the best results were obtained with the use of a mixture of meat and butter-fish in the proportion of 1 to 1. Oxygen tests proved of value as to the number of fish we could carry in the ponds.

Some fish culturists we consulted were of the opinion that the concrete pools were causing the trouble and that dirt pools would give better results. I had used both types before coming to Hackettstown and preferred those of concrete as being more sanitary.

The use of dirt ponds during the third year, 1915, proved quite satisfactory for fish that had attained a length of 2 inches, but were of no value for small fish on account of the profuse growth of the alga, *Spirogyra*. The removal of the *Spirogyra* necessitated the continual stirring up of the ponds, while, on the other hand, if it were not removed, gill trouble developed among the small fish. The fish did poorly under both conditions.

During the fourth year, 1916, tests carried on in two ponds, 50 by 180 feet, and 3 to 5 feet in depth, produced only 25,000 fingerling trout, whereas four times that number might reasonably have been expected. Two similar ponds proved satisfactory for yearlings, 6,000 fish, 6 to 8 inches long, having been produced in each pond.

In order to hold the water at a low temperature it was necessary to use more water than could well be spared, until the supply from a new reservoir became available. The water, with a temperature of 55 degrees F. on entering the first pond at the rate of 20,000 gal. per hour, was 74 degrees F. on leaving the second pond. The water remained at 74 degrees for only a short period during each day and would then drop back to 58 or 56 degrees during the night. A large mortality among the small fish under two inches long was the result of this fluctuation in temperature. The large fish did not seem to be affected by this temperature unless subjected to it for a prolonged period. Four small spring-fed ponds, three of concrete and one of dirt, with water at 52 to 60 degrees and with aquatic growth consisting of *Elodea* and *Potamogeton crispus*, gave good results. We introduced these plants into large ponds and obtained good results with yearlings and breeders, but not with small fish.

We also discovered that affected fish, placed in waste water running from ponds that contained an abundance of *Potamogeton crispus*, *Elodea*, water-cress, snails, shrimp, stoneflies, caddisflies, *Asellus* and black fly larvae, soon became very active and healthy. Microscopic examinations of the heart's blood showed no *Bacterium truttae* in a great many fish, while others showed only slight traces of disease.

The fifth year, 1917, we took two chains of ponds, ten each, and brought in a supply of water from a four-acre pond. This was supplied by spring and brook water, with a temperature of from 70 to 75 degrees F. and contained *Potamogeton crispus*, *Elodea*, water-cress, snails, shrimp, stoneflies, caddisflies, *Asellus* and black fly larvae. We set valves on the pipe line supplying spring water of 52 degrees and pond water of 72 degrees to get an average temperature of 62 degrees, which was similar to conditions of the brook water previously described. Everything worked well and we thought we were on the right track until on September 1st, we got an outbreak of a disease caused by a protozoan known as *Ichthyophthirius multifillis*.

The sixth year, 1918, in ponds 50 by 180 feet, which were the same as those employed in 1916, we obtained tangible results by running a sufficient quantity of water through to keep temperature below 65 degrees, about 35,000 gallons per hour.

In February of the present year, the President of our Department gave me permission to engage Mr. Wm. T. Foster, Professor of Biology in Lafayette College, to give scientific assistance in carrying on experiments. Wednesday and Saturday of each week were devoted to this work which extended to July first. Special attention was given to the more important diseases affecting brook, brown and rainbow trout.

In view of the fact that this disease was confined to certain pools, Professor Foster, by microscopic examination, was soon able to discover the disease organisms in those fish showing pathologic symptoms, for the purpose of discovering some means of preventing the disease or effecting a cure as the disease appeared. These examinations began in February and are still being carried on. Hundreds of brook, brown and rainbow trout were examined to ascertain the cause of the disease conditions which appeared from time to time.

There were two very important diseases with which we came in contact. One was a blood disease, caused by the microscopic organism known as *Bacterium truttæ*, and the other by a protozan known as *Ichthyophthirius multifillis*. (A translation of pp. 122-128 of Hofer's Fischkrankeiten, München, 1904, was furnished by the U. S. Bureau of Fisheries). The prescribed measures were employed and proved efficacious.

In the case of the first named disease the fish could be readily picked out and every fish exhibiting typical pathological conditions showed the presence of the organisms in large numbers in the heart's blood. The morphological characteristics of these organisms have been fully described by Mr. M. C. Marsh, formerly of the U. S. Bureau of Fisheries, but so far as we have been able to ascertain, no direct preventive or curative measures have been discovered up to this time. We have not carried on our investigations far enough to entirely eliminate the organisms, but we have succeeded in eliminating the disease this year in some of our ponds and in reducing the mortality in others more than 90% by employing the following methods:

Introduction of *Potamogeton crispus*, *Elodea* and water-cress in clusters, to the extent of about ten per cent of the pond area in ponds of spring water at 52 to 62 degrees. In ponds 50 feet long and 7 feet wide with a depth of water of 2 to 2½ feet, it is necessary

to introduce new plants every three or four weeks, in order to enable them to grow to the surface to attract the various flies and insects. New plants starting from bottom should be controlled so that the excrement from the fish will not lodge and foul the ponds. Keeping them in clusters prevents fouling, as men can work around them from the top of the walls with long-handled brushes.

We then place in the pools according to the number of the fish, one or two galvanized iron boxes, 18 inch sq., 24 gauge, open at the bottom, with a one-inch iron band around the bottom. Holes are drilled through the band for 5-16 inch iron rods, used to hold a wood frame containing trays for fly-blown meat. A small pin hole is punched through the top to permit the gas to escape, in order not to kill maggots. The bottom of this box is submerged one inch in the water to do away with objectionable odors. Any stale or tainted meat will do. The big blue flies produce the largest maggots. Care will have to be taken to keep beetles away from the meat or they will destroy the fly maggots as fast as they hatch.

Also we thoroughly roil ponds twice a week. One half yard of field loam to twenty ponds is sufficient.

## Tables.

It will be noted by the table that the losses of brook trout for the month of July is 16.5%, brown trout fingerlings 61.4%, brown trout yearlings 6.7%, rainbow trout fingerlings 1.3%, rainbow trout yearlings 7.3%. Loss of all kinds 18.9%.

August losses—Brook trout fingerlings 1.7%, brown trout fingerlings 1.9%, brown trout yearlings 4%, rainbow trout fingerlings 99-100 of 1%, of rainbow trout yearlings 5.6%. Loss of all kinds 2.2%.

September losses—Brook trout fingerlings 1.2%, brown trout fingerlings 3-50 of 1%, brown trout yearlings 1.4%, rainbow trout fingerlings 1-50 of 1%, rainbow trout yearlings 1.3%. Loss of all kinds 1-20 of 1%.

The above losses occur in spring water at 52 to 62 degrees. The same fish were used for the entire period.

DAILY LOSS, MONTH OF JULY.

| DATE | No. brook trout fingerlings used in test—1,000. | No. brown trout fingerlings used in test—54,000. | No. brown trout yearlings used in test—11,000. | No. rainbow trout fingerlings used in test—100,000. | No. rainbow trout yearlings used in test—34,000. | Total 200,000 |
|---|---|---|---|---|---|---|
| July 1 | 10 | 1852 | 23 | 4 | 50 | 1939 |
| " 2 | 12 | 2320 | 80 | 0 | 80 | 2492 |
| " 3 | 11 | 998 | 32 | 7 | 54 | 1102 |
| " 4 | 12 | 1119 | 46 | 11 | 60 | 1248 |
| " 5 | 9 | 1815 | 25 | 23 | 80 | 1952 |
| " 6 | 11 | 1644 | 28 | 34 | 64 | 1781 |
| " 7 | 13 | 1474 | 30 | 15 | 91 | 1623 |
| " 8 | 9 | 1859 | 7 | 8 | 57 | 1940 |
| " 9 | 12 | 1419 | 10 | 15 | 90 | 1546 |
| " 10 | 8 | 3197 | 10 | 10 | 55 | 3280 |
| " 11 | 7 | 2519 | 15 | 19 | 84 | 2644 |
| " 12 | 5 | 2195 | 11 | 40 | 105 | 2355 |
| " 13 | 9 | 1889 | 44 | 29 | 75 | 2046 |
| " 14 | 8 | 1582 | 32 | 17 | 91 | 1730 |
| " 15 | 6 | 986 | 12 | 25 | 111 | 1140 |
| " 16 | 5 | 566 | 14 | 11 | 106 | 702 |
| " 17 | 4 | 776 | 11 | 34 | 108 | 933 |
| " 18 | 3 | 650 | 24 | 11 | 130 | 818 |
| " 19 | 2 | 320 | 27 | 14 | 76 | 439 |
| " 20 | 1 | 474 | 19 | 12 | 52 | 558 |
| " 21 | 0 | 520 | 19 | 11 | 48 | 598 |
| " 22 | 1 | 497 | 25 | 17 | 57 | 597 |
| " 23 | 2 | 474 | 18 | 2 | 70 | 566 |
| " 24 | 1 | 254 | 20 | 24 | 123 | 422 |
| " 25 | 2 | 608 | 29 | 755 | 101 | 1495 |
| " 26 | 0 | 474 | 18 | 2 | 70 | 564 |
| " 27 | 1 | 297 | 14 | 7 | 66 | 385 |
| " 28 | 0 | 176 | 22 | 13 | 82 | 293 |
| " 29 | 1 | 111 | 20 | 28 | 74 | 234 |
| " 30 | 0 | 52 | 28 | 34 | 105 | 219 |
| " 31 | 0 | 60 | 23 | 60 | 85 | 228 |
| | 165 | 33,177 | 736 | 1,292 | 2,500 | 37,870 |
| | Loss 16.5% | Loss 61.4% | Loss 6.7% | Loss 1.3% | Loss 7.3% | Loss 18.9% |

DAILY LOSS, MONTH OF AUGUST.

| DATE | No. brook trout fingerlings used in test—835. | No. brown trout fingerlings used in test—20,823. | No. brown trout yearlings used in test—10,264. | No. rainbow trout fingerlings used in test—98,708. | No. rainbow trout yearlings used in test—31,500. | Total 162,130 |
|---|---|---|---|---|---|---|
| Aug. 1 | 1 | 49 | 25 | 70 | 55 | 200 |
| " 2 | 1 | 24 | 20 | 16 | 97 | 158 |
| " 3 | 0 | 22 | 29 | 25 | 89 | 165 |
| " 4 | 1 | 20 | 4 | 54 | 80 | 159 |
| " 5 | 0 | 19 | 15 | 73 | 58 | 165 |
| " 6 | 0 | 11 | 15 | 35 | 73 | 134 |
| " 7 | 0 | 9 | 11 | 18 | 81 | 119 |
| " 8 | 1 | 8 | 11 | 24 | 89 | 133 |
| " 9 | 0 | 6 | 8 | 33 | 79 | 126 |
| " 10 | 0 | 16 | 13 | 28 | 85 | 142 |
| " 11 | 1 | 26 | 13 | 26 | 64 | 130 |
| " 12 | 1 | 14 | 12 | 28 | 62 | 117 |
| " 13 | 0 | 11 | 16 | 32 | 60 | 119 |
| " 14 | 0 | 16 | 20 | 18 | 72 | 126 |
| " 15 | 1 | 12 | 27 | 45 | 66 | 151 |
| " 16 | 0 | 9 | 20 | 35 | 60 | 124 |
| " 17 | 1 | 12 | 24 | 40 | 63 | 140 |
| " 18 | 1 | 14 | 28 | 40 | 70 | 153 |
| " 19 | 1 | 17 | 4 | 35 | 70 | 127 |
| " 20 | 0 | 16 | 19 | 30 | 64 | 129 |
| " 21 | 0 | 15 | 15 | 28 | 68 | 126 |
| " 22 | 0 | 14 | 18 | 29 | 69 | 130 |
| " 23 | 0 | 2 | 2 | 47 | 22 | 73 |
| " 24 | 0 | 4 | 8 | 40 | 24 | 76 |
| " 25 | 1 | 6 | 10 | 38 | 17 | 72 |
| " 26 | 0 | 7 | 1 | 16 | 12 | 36 |
| " 27 | 0 | 0 | 9 | 17 | 24 | 50 |
| " 28 | 1 | 3 | 4 | 15 | 26 | 49 |
| " 29 | 1 | 7 | 4 | 10 | 19 | 41 |
| " 30 | 1 | 5 | 5 | 18 | 14 | 43 |
| " 31 | 1 | 9 | 8 | 22 | 30 | 70 |
| | 15. | 403 | 418 | 985 | 1,762 | 3,583 |
| | Loss 1.7% | Loss 1.9% | Loss 4% | Loss .99% | Loss 5.6% | Loss 2.2% |

DAILY LOSS, MONTH OF SEPTEMBER.

| DATE | No. brook trout fingerlings used in test—820. | No. brown trout fingerlings used in test—20,420. | No. brown trout yearlings used in test—9,846. | No. rainbow trout fingerlings used in test—97,723. | No. rainbow trout yearlings used in test—29,738. | Total 158,547 |
|---|---|---|---|---|---|---|
| Sept. 1 | 1 | 1 | 4 | 8 | 10 | 24 |
| " 2 | 0 | 1 | 3 | 10 | 14 | 28 |
| " 3 | 0 | 0 | 8 | 10 | 11 | 29 |
| " 4 | 1 | 0 | 7 | 6 | 21 | 35 |
| " 5 | 0 | 1 | 4 | 8 | 16 | 29 |
| " 6 | 0 | 0 | 13 | 6 | 12 | 31 |
| " 7 | 1 | 1 | 9 | 3 | 10 | 24 |
| " 8 | 1 | 0 | 4 | 2 | 7 | 14 |
| " 9 | 0 | 1 | 4 | 7 | 15 | 27 |
| " 10 | 1 | 0 | 5 | 4 | 10 | 20 |
| " 11 | 1 | 1 | 3 | 6 | 12 | 23 |
| " 12 | 0 | 4 | 2 | 5 | 28 | 39 |
| " 13 | 1 | 1 | 1 | 3 | 16 | 22 |
| " 14 | 0 | 0 | 1 | 4 | 20 | 25 |
| " 15 | 0 | 0 | 4 | 8 | 12 | 24 |
| " 16 | 0 | 11 | 1 | 6 | 8 | 26 |
| " 17 | 0 | 7 | 6 | 4 | 7 | 24 |
| " 18 | 0 | 5 | 4 | 0 | 7 | 16 |
| " 19 | 1 | 10 | 18 | 5 | 13 | 47 |
| " 20 | 0 | 10 | 6 | 7 | 25 | 48 |
| " 21 | 1 | 8 | 9 | 5 | 20 | 43 |
| " 22 | 0 | 12 | 6 | 7 | 24 | 49 |
| " 23 | 0 | 9 | 4 | 17 | 0 | 30 |
| " 24 | 0 | 6 | 0 | 7 | 25 | 38 |
| " 25 | 0 | 5 | 2 | 0 | 13 | 20 |
| " 26 | 0 | 6 | 3 | 9 | 10 | 28 |
| " 27 | 1 | 11 | 0 | 6 | 9 | 27 |
| " 28 | 0 | 8 | 6 | 14 | 13 | 41 |
| " 29 | 0 | 2 | 3 | 10 | 16 | 31 |
| " 30 | 0 | 2 | 0 | 36 | 5 | 43 |
| | 10 | 123 | 140 | 223 | 409 | 905 |
| | Loss 1.2% | Loss .06% | Loss 1.4% | Loss .02% | Loss 1.3% | Loss .57% |

# THE PRESERVATION OF THE ALEWIFE.

By David L. Belding,
*Biologist of the Massachusetts Fish and Game Commission.*

The problems confronting the commercial fisheries offer a most fertile and important field of investigation for economic biology. Unlike the majority, the alewife fishery presents a complete problem in itself, and, because it furnishes a splendid illustration of the practical value biological study may play in the preservation of a commercial fishery, it has been chosen for the subject of this paper.

The alewife or branch herring (*Pomolobus pseudoharengus*) is the most abundant food fish inhabiting the rivers of the Atlantic Coast, from Maine to Florida, and with the disappearance of the shad has become commercially the most valuable anadramous fish in Massachusetts. Ever since the landing of the Pilgrims, when the alweife provided the most readily available source of food for the early inhabitants of New England, it has been closely related to the prosperity of the shore towns, where it has always been held as a public asset. The successful re-establishment of this fishery would benefit the shore towns directly, and indirectly would prove of even greater value to the public.

The alewife is of value as food, as bait, and as a food supply for other fish. Either fresh or cured, the alewife forms an excellent and inexpensive article of diet. Because of its abundance and comparative cheapness, it is satisfactory as a bait supply. However, of greater importance is the attraction it forms for large schools of pollock, bluefish, striped bass, squeteague and other food fishes, which come to our shores to prey upon the young alewives when they descend the coastal streams. The simultaneous decline of the alewife and shore fisheries suggests that there is a direct relation between the two, and that the success of the fishing towns along the coast is dependent in a considerable measure upon the flourishing condition of the alewife fishery.

This paper presents the results of a biological study of the Massachusetts alewife fishery, and the practical application of remedial measures based on this study.

Its presentation naturally falls into three divisions:

I. Natural history of the alewife.
II. Present condition and decline of the fishery.
III. Application of remedial measures.

## I. Natural History.

*Distribution.*—While the majority of the numerous herring species are confined to the ocean, some ascend the rivers for the purpose of spawning. In the latter class is the alewife, which is taken commercially along the Atlantic Coast from Nova Scotia to Virginia. In Massachusetts practically all the coastal streams in former days were inhabited by this fish, but, at the present time in many localities the fishery no longer exists.

*Reproduction.*—During the spawning season, which lasts from March to July, the alewife ascends the tidal streams to deposit its spawn in the fresh ponds, and later returns to the ocean. Two classes of spawning ponds are found in Massachusetts: (1) The ordinary tributary tidal stream with one or more fresh water ponds at its source, at a variable distance from the ocean, and (2) the typical fresh or brackish water shore pond, separated from the salt water by a narrow sand beach, through which passes a natural or artificial channel.

The adhesive eggs are deposited in shallow water, where they adhere to stones, gravel, sand, logs and other materials. During the act of spawning, the alewives swim in small schools around the edges of the pond, one female being commonly accompanied by 6 to 7 males. The temperature of the water is the principal factor regulating the time of spawning and rate of development of the eggs, warm water accelerating the process of hatching. The incubation period for artificially hatched eggs ranges from 48 to 96 hours with a water temperature of 67 to 72 deg. F.

*Growth.*—The alewife when hatched is about one-fifth of an inch in length, but, under normal conditions, rapidly increases in size, becoming a slim, translucent creature with broad tail, prominent dorsal fin, and relatively large eye. The young alewife attains the approximate length of two to four inches by fall, at the time it descends from the breeding grounds to the ocean. At one year, when detained in fresh water, it measures about 6 inches.

Its subsequent growth is somewhat a matter of conjecture. Adult fish range from 7 to 12.5 inches, the majority, presumably three and four year olds, running from 10 to 12 inches.

In late summer schools of various sized alewives are found in the spawning ponds, depending upon the following factors:

(1) Geographical location, spawning taking place earlier in southern waters.

(2) Time of spawning, eggs from the first run hatching two months earlier than the last.

(3) Temperature, abundance of food supply, and size of spawning ponds.

*Food.*—The food of the adult alewife consists mostly of the plankton forms, such as diatoms, algae, and small crustaceans. Instances have been cited where alewives have risen to the artificial fly, and also have been taken with young eels as bait.

*Enemies.*—Among the enemies of the young and adult may be mentioned fish, birds, disease and man.

*Migration.*—The history of the alewife in the interval between its descent to the ocean and its return as a mature fish is as yet unknown. We are better acquainted with the freshwater part of its life cycle. Governed primarily by temperature, the fish approach the coast at a definite period in the spring, appearing first in the rivers of the Middle South as early as March, and in Canada in May. In Massachusetts they usually are noticed toward the last of March or the first of April. After spawning, the adult fish return to salt water in a lean, emaciated condition. Whether these fish spawn again has not been determined.

*Parent Stream Theory.*—From observations in handling local alewife fisheries, the "Parent Stream Theory" has been evolved. Briefly, the theory is that the young alewives descending from a particular pond and stream will return as adult fish to the same stream for spawning, thus establishing a continuous chain. There are good reasons for us to consider this theory favorably. Practical demonstration has shown that fisheries have been created in streams which had no alewives by the simple expedient of placing mature spawning alewives in the headwaters. The offspring returned as adult fish, to the same spawning grounds, thus establishing a fishery. Similarly, depleted fisheries have been re-estab-

lished. Experience has likewise shown that a poor year, when but few alewives reach the spawning grounds, is followed at a stated interval by a corresponding lean year. From such observations we can accept the "Parent Stream Theory" as the best working hypothesis available.

## II. The Fishery.

*Operation.*—In Massachusetts there are two types of alewife fisheries, the natural and the artificial, both of which have been developed under town control. In early days nearly every coast town possessed one or more natural streams upon which fisheries were soon established under town management, and in a few cases by private individuals. Unless the fishery was completely ruined, its operation was conducted in one of four ways: (1) free, (2) town operated, (3) leased, and (4) private ownership.

*Methods of Catching.*—Every householder was early given the time-honored privilege of obtaining alewives, in whatever manner and at whatever time he desired. Later, when the towns exercised control over the alewife fisheries, certain places were designated and set aside by law as locations where alewives could only be taken, and fishing was forbidden elsewhere. These stations have been developed by regulating the water flow, and by building screened locks and weirs, in which the alewives are taken on stated days of the week. From the catching pens, the alewives are removed by seines, or dipped with scoop nets, according to the method best suited.

*Marketing.*—While the majority of the fish taken during the spring run are cured, an increasing number are marketed fresh. In 1918, Boston alone used over 2200 barrels of fresh alewives, showing that the value of the alewife as a food is becoming more appreciated.

### DECLINE.

While in some streams the alewife fishery has held its own, or even improved, it has diminished to such an extent usually that we can accept without reservation the general statement that the alewife fishery as a whole has declined. The causes which have contributed to this condition are so numerous and so complex that the exact separate influence of each cannot be absolutely deter-

mined. Four prominent factors are (1) destruction of the spawning grounds, (2) obstructions which prevent the alewives from passing to the spawning grounds, (3) pollution of streams, and (4) overfishing.

*Destruction of Spawning Grounds.*—Many alewife streams which once were important can never be restocked because their former spawning grounds are no longer available. Some have been taken for water supplies, screened, and the original outflow diverted. Natural agencies and artificial changes such as drainage and deforestation have altered spawning grounds and streams.

*Obstructions.*—One of the first steps in the development of a fishery is the removal of all obstructions to give free access to the spawning pounds. Natural changes may alter the course or flow of streams in such manner as to prevent the passage of fish. Natural or artificial falls, dams, unless equipped with fishways, and material of various kinds prevent or make difficult the passage of alewives.

(1) *Dams.*—Dams are the inevitable result of the inroads of colonization following the waterways. In former days water power was even a greater necessity than in the present era of coal, gas and electricity. As manufacturing became of greater moment, more water power was required, and eventually numerous dams were erected upon the streams of Massachusetts. The mere presence of dams is not dangerous. Only when they are unequipped with fishways or are not opened during the spring run do they become a menace. Properly supplied with adequate passageways, dams would never have exerted a pernicious influence upon the alewife fishery.

(2) *Cranberry Bogs.*—A water supply is essential for the successful operation of the cranberry industry, and in southern Massachusetts numerous bogs are found along the alewife streams. The cranberry industry affects the alewife fisheries by:

(*a*) The erection of small dams usually not equipped with fishways, the owners of which are supposed to raise their sluiceboards during the annual run. However, at certain seasons for the welfare of his bog, the owner may find it desirable to have the water remain for a longer period, and thus block the progress of the fish.

(*b*) Changing the course of the stream by ditches and canals which are inferior to the natural channels.

(*c*) Temporarily flooding the bogs during the early fall, thus stranding the young alewives which are descending to salt water.

*Pollution.*—There are two sources of pollution in the coastal streams, (1) sewage, and (2) manufacturing wastes. The former comes from sewage systems and from private houses; the latter from mills of various kinds located on the streams.

Pollution affects fish in three ways: (1) by directly interfering with the normal habits of the adult fish, (2) by destroying the eggs and young, and (3) by indirectly affecting the environment and food supply.

*Overfishing.*—The principal cause of the decline of the alewife fishery has been overfishing as a result of unwise regulation. Unless a reasonable number of adult alewives are permitted to reach spawning grounds, the destruction of any fishery is inevitable. Almost universally, overfishing has been brought about by faulty methods of regulating the industry through town control, which is the common practice in Massachusetts. The alewife streams where the public is given the privilege of free-for-all fishing under various obscure regulations, most of which are seldom enforced, have become the poorest producers. Fisheries directly operated by towns are also unsuccessful, owing to laxity in management, and to town politics. The popular and easy expedient of annually leasing the fishery to the highest bidder has placed a premium upon its exploitation, and has directly encouraged overfishing. Naturally the purchaser, uncertain of obtaining the fishery for the future years, would drain its resources to the utmost by taking all available fish.

## III. Remedial Measures.

As briefly outlined in the previous pages, the biological investigation of the Massachusetts alewife fishery has shown its present condition, the causes contributing to its decline, and has brought out certain points in the life history and habits of the alewife which furnish a basis for establishing cultural methods.

The requisite steps in this reconstruction work are:

(1) An unobstructed and uncontaminated passageway from salt water to the spawning grounds.

(2) Artificial restocking of depleted streams and the creation of new fisheries in favorable localities.

(3) Adequate and efficient methods of regulating the fishery.

In the spring of 1919, the work which had been suspended during the war was resumed, and first of all the important problem of obtaining a clear passageway for the fish to the spawning grounds, as a preliminary requisite for stocking was taken up. At the same time preliminary cultural work, including the artificial hatching of alewife eggs guaranteed beyond a reasonable doubt the future success of restocking the depleted streams.

### FISHWAYS.

The first step in the reconstruction of the alewife fishery is the removal of existing obstructions to make a clear passageway for alewives. Two conditions present difficult problems—impassable dams and pollution. The first and most important has been met by installing workable fishways, the latter is still unsolved.

*Requirements.*—The requirements for a successful fishway are:

(1) Easy and rapid passage for all species of fish, with uniform flow of water, gradual ascent, and absence of high barriers. (2) A minimum sacrifice of water in the interest of the dam owners. (3) An entrance into which the fish are readily directed. (4) A firm, solid construction, resistant to freshets, or one which may readily be removed when not in use.

*Installation.*—The chief point to remember is that it is not the type of fishway, *but how it is installed*, which determines its success or failure, since each dam presents certain peculiarities which necessitates individual treatment. In installing a fishway the following conditions must be considered:

(1) Water Flow.—Provision for a constant flow of water, irrespective of variations in the level of the pond, can be made by an adjustable upper section of the fishway to correspond to the water level, a gate situated at the lowest probable water line, or several gates at different levels.

(2) Entrance.—Instinctively the fish follow the greatest flow of water, usually up the main stream to the dam. Therefore, the entrance must be either directly beneath the dam where the fish will naturally swing into it, or there must be some means of

directing them. Screening the stream with an iron grating is a successful though expensive method. A submerged stone barrier leading to the fishway entrance has proved at times effective.

(3) CONSTRUCTION.—The nature of the soil and height of the dam largely influence the difficulty and expense of construction.

(4) DESTRUCTION.—Destruction of a fishway by spring floods may be partially avoided by building a concrete structure, locating the fishway where it is subject to the least damage, and having part or all removable when not in use.

*Standard Fishways.*—A successful fishway which will take all species of anadramous fish has never been invented. In our work two types of fishways have been designed, and have proved highly satisfactory for the alewife streams. No claim is made that these are the long sought universal fishways, or that they are suited for other species of fish. We know that they are successful for alewives, and that their simple type makes them well adapted to Massachusetts streams.

It was early realized that the main difficulty lay not in the fishway itself, but its adaptation to various prevailing conditions. Two distinct standard types which can be adapted to all ordinary dams have been designed.

The first type, *The David Fishway*, may be either of concrete or wood construction. With its sloping bottom and irregular baffles it resembles the Brackett type, but possesses the additional qualifications of frequent rest pockets, and a steady, uniform flow of water, which is controlled by the upper gate. Although more expensive than the second standard type, it can be advantageously installed in a limited space over an irregular course.

The second type, *The Straight Run Fishway*, is especially adapted for low dams where the contour of the stream bed affords a gradual fall. This primitive form of fishway more nearly resembles a natural swiftly broken stream, and possesses the advantage of stimulating the rapid ascent of the alewives.

Dam owners are required by law, when requested by the Fish and Game Commission, which furnishes complete plans and specifications for every fishway, to install suitable fishways at their own expense, and keep them open at specified times, under penalty of a fine of $50.00 per day for non-compliance. In spite of the difficulty in obtaining the willing co-operation of the dam owners,

who naturally object to the expense of construction, the work of installing fishways is steadily progressing, and it is hoped that soon all the potentially productive streams will be completely equipped.

## POLLUTION.

With the continuous growth of towns and cities, unless better methods of disposal are devised and more stringent regulations enforced, the amount of water pollution is inevitably bound to increase. The alewife streams form part of this general problem, and similar methods of treatment are necessary. The pollution question is so important, difficult and complex in its inevitable conflict with large manufacturing interests, that to dismiss it in the few words necessitated by the limited scope of this paper seems most inadequate.

Sewage, except in the larger rivers, is of relatively less importance than the trade wastes, which comprise acids, alkalies and miscellaneous chemicals from nail and iron works, rubber factories, wool scouring establishments, bleacheries, laundries, dye works, leather factories, etc.

The following plan of approaching the pollution problem has been observed. All cases of pollution on alewife streams have been recorded and brought to the attention of the owners. Educational propaganda is under way, but as yet no effort has been made to use extreme legal measures.

(1) Education.—The evil effects of pollution are presented to the public by lectures and newspaper articles.

(2) Survey.—Every source of pollution is recorded, and the co-operation of the owner in its removal requested.

(3) Disposal of Waste.—Through the expert advice of the State Board of Health, satisfactory means of waste disposal at the least possible expense to the manufacturers are recommended.

(4) Utilization of Waste.—The manufacturers are shown how they can utilize their waste products to best advantage, and thereby cut down or completely eliminate the expense of maintaining a disposal system.

(5) Legal Action.—As an extreme measure, if the owner refuses to co-operate, legal action for the elimination of pollution, as provided under the present laws, may be instituted.

STOCKING METHODS.

All stocking methods are based upon the "Parent Stream Theory," which presupposes that the young alewives return as mature fish to the same waters where they were born. Depleted streams can be restored and new fisheries created by stocking, through the introduction of young alewives into the headwaters, which may be accomplished in two ways:

(1) Transplanting mature, ripe alewives to the spawning ponds.

(2) Planting artificially hatched fry.

*Mature Alewives.*—The yield of certain depleted streams has been greatly increased by transplanting into their headwaters spawning alewives from productive streams. It is sure, practical, and at the present time the only certain step for restocking unobstructed streams. It possesses the great objection of expense in catching and transporting the adult fish. Possibly small alewives could be seined in the late summer and similarly transported at a less cost.

*Artificial Hatching.*—The ideal method of propagation would be to plant artificially hatched alewives. Sufficient preliminary work has been carried out along this line to indicate that commercial hatching is feasible.

(1) *Ripe Fish.*—The principal obstacle is obtaining ripe fish for stripping. It is impracticable to obtain the fish in their journey up stream, since the ratio of males to females is large, and practically all the eggs are "green" at this time.

Seining the fish on the spawning grounds seems the logical method, unless the alewives can be held in pockets on their journey up stream until the eggs ripen. The ratio of male and female necessitates handling large numbers of superfluous males, as well as many unripe females. However, a sufficient quantity of eggs may be secured for the work with labor and patience.

(2) *Hatching.*—When seined the fish are stripped in the usual method. After fertilization, owing to their adherent nature, the eggs will mass together, but this may be obviated by constant stirring and by changing the water every five minutes until they harden. When first placed in open MacDonald hatching jars, the eggs tend to adhere to each other, but later they separate, becoming firm, hard and a light coffee color. The fry which have the appear-

ance of fine transparent threads attached to a relatively large yolk sac, can be held only for a short time in tanks before planting.

(3) *Planting.*—The advantage of artificial hatching over natural spawning is the protection of the eggs from the inroads of suckers, white and yellow perch, which frequent the spawning grounds. For protection from these fish, the fry should be liberated over a wide territory.

In spite of the great difficulty in obtaining the ripe fish, the artificial hatching of alewives is a practical procedure, but the beneficial effects of planting the fry cannot be demonstrated for several years.

### REGULATION OF FISHERY.

The third important step in preserving the fishery is the proper legal regulation which will allow cultural and protective measures to achieve the best results. In place of the present voluminous special legislation for the alewife streams of Massachusetts, a few simple, readily enforced general laws, capable of local modification, should prove of great benefit in developing the alewife fishery.

*Control.*—The best method of operating the fishery would be a central board of control, with local representation, which would have adequate powers to enforce the laws, delegate authority and regulate each individual fishery in the interests of the whole. Thus each fishery would be freed from local disputes and irresponsible manipulation.

*Lease.*—The fishery should be leased to private individuals. A long term lease, not less than five years, is necessary, since the short term lease places a premium upon exploitation. The longer period will encourage a purchaser to safeguard the fishery in all ways.

*Closed Seasons.*—Closed seasons are beneficial only when they are used to supplement and protect constructive cultural work. A closed season is of direct benefit to the alewife fishery when the alewives are given a chance to spawn in large numbers, thus supplying a natural means of stocking. In all cases of depletion at least a three year period should be exacted, and the necessity of a further closed season determined by the results obtained, especially in cases where stocking operations have been simultaneously

carried on. In fairly prosperous fisheries, the one year closed season alternating with the five year lease should prove a good prophylactic measure for insuring the welfare of the fishery.

*Season.*—The length of the season should be the same throughout the state, and not exceed a maximum of 60 days. The exact dates for the commencement of fishing should be determined for each individual stream.

*Fishing Days.*—The time of catching should not exceed three consecutive days per week. Any combination may be selected, but the period from sunrise Tuesday to sunset Thursday is recommended as giving the best opportunity for preparing and disposing of the catch.

*Fishing Places.*—To insure easy enforcement of the law fishing should be conducted at definite places. Suitable equipment in the form of buildings, catching basins, etc., should be provided at these carefully selected places. Only in exceptional instances should more than one catching place be allowed per town, viz., seining privileges on the larger rivers.

*Methods of Capture.*—The methods of fishing should be clearly and definitely stated. The length and size of mesh for seines should be regulated.

*Uniform Sale.*—The method of conducting the sale of the alewife fishery leases should be uniform as regards time of sale, submitting of bids, awarding of contracts, payment, forfeiture and all other provisions.

## SUMMARY.

The following points have been considered in this paper:

(1) The valuable alewife fishery in Massachusetts has declined because of unwise legislation, overfishing and obstructed streams.

(2) A study of the life history and habits of the alewife has indicated the proper methods of checking this decline.

(3) Experimental constructive work in providing unobstructed passageways to the spawning grounds, and in restocking depleted streams, has so far given excellent results.

(4) A satisfactory type of fishway for alewives has been designed.

(5) Depleted streams can be restocked and new fisheries developed by transplanting spawning alewives.

(6) Alewives can be successfully hatched artificially.

(7) Efficient laws are necessary for the proper uniform regulation of the fishery.

*Discussion.*

MR. JOHN W. TITCOMB, of New York, asked the following questions: What is the ratio of males to females during the run? At what temperature does the alewife spawn? What is the height of the highest successful dam, and how is the current directed so as to attract the fish to the fishery? Does each town make its own laws to regulate the fishery of its own district, and do you expect the towns to conform to any uniform rule?

MR. BELDING replied as follows: You will see one female followed by six or seven males. In seining, one time, I took only two females in a hundred fish. The fish we took spawning were in water at 72 degrees F., but we did not begin in time for the first part of the run. The highest dam provided with a fishway in successful operation is about fifteen feet and the breadth of the stream in this case is about 60 feet. There is no arrangement for directing the current at this dam. At other places we have used gratings during the run, which were hauled up when not needed. These gratings or screens extend across the stream. Each town regulates its own fishery entirely as it sees fit and the only check the state has on it is, that after the town has once established an alewife fishery it must keep it up and not allow it to deteriorate. It will be a very hard fight to get the towns to conform, but I think it can be done in some way in which each town will have the oversight of its own particular fishery, yet will be controlled by uniform laws that will be amenable to local adaptation. The minute we try to establish any system by which the Fish and Game Commission will take over the control of the fishery, there will be opposition in the town.